

Lecture 13 - Oligopoly

ECON 3070 - Intermediate Microeconomic Theory

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Overview

So far we've discussed markets with either one firm or with a large number of firms.

- In this chapter, we will discuss markets with a small number of firms.
- We will look at a couple of different models of competition with two firms and discuss the resulting equilibria in each.

Market Structure

Below is an illustration of different market structures:

Product Differentiation	Number of Firms			
	Many	Few	One Dominant	One
<i>Firms produce identical products</i>	Perfect competition (Chapter 9) Example: fresh-cut rose market	Homogeneous products oligopoly Example: U.S. glass container market	Dominant firm Example: U.S. light bulb market	Monopoly (Chapter 11) Example: Internet domain name registration ^a
<i>Firm produce differentiated products</i>	Monopolistic competition Example: local physicians markets	Differentiated products oligopoly Example: breakfast cereal market	No applicable theory	

Market Structure

Aside from the two that we've discussed in depth, there are four more that we will talk about:

1. A **homogeneous products oligopoly market** is one in which there are few sellers, who all sell a similar product.
 - An example is the U.S. glass container industry. Three firms account for 82% of sales.
 - In the market for titanium dioxide, several large firms sell almost the exact same product.

Market Structure

2. In a **dominant firm market**, one large firm possesses a large share of the market but competes against many small firms.

- An example is the U.S market for light-bulbs.
- Many small firms compete, but GE alone counts for 50% of sales.

Market Structure

3. In **differentiated products oligopoly markets**, a small number of firms sell products that are substitutes, but differ in some way.
- Coke and Pepsi are a good example. These two firms dominate the market, but face competition from numerous smaller companies.
 - In the U.S. breakfast cereal market, Kellogg, General Mills, Post and Quaker Oats sell more than 85% of all cereal.
 - In Japan, Asahi, Kirin, Sapporo, and Suntory account for nearly 100% of Japanese beer sales.

Market Structure

4. Finally, **monopolistic competition** refers to a market in which many small firms produce differentiated products.
- Examples include dry cleaners, physicians, and restaurants.

Market Structure

Economists use various metrics to describe market structure. The **four-firm concentration ratio (4CR)** calculates the share of industry sales accounted for by the four largest firms.

- For example, if the four largest firms have 3%, 2%, 2% and 1% of sales, then the market would have a 4CR of 8.

Another metric is the HHI, which is the sum of square market shares for all firms.

- If one firm has all of the market share, then $HHI = 100^2 = 10,000$. This is the maximum possible value.
- On the other hand, if 100 identical firms each have 1% of market share, $HHI = 100 * (1^2) = 100$.

Cournot Oligopoly Model

An important feature of oligopoly models is competitive interdependence.

- The decisions of every firm significantly impact the profits of competitors.

One model of oligopoly is the **Cournot model**.

- We will consider two firms in the market, but it can be extended.

Cournot Oligopoly Model

Firms choose output quantity simultaneously and noncooperatively (without colluding). Once quantities are chosen, price instantly adjusts.

- Firm's output choice depends on market price, and market price depends on both firms' output levels.
- Firms don't know competitor's output choice, so they make their choice based on expectation.
- In other words, firm A makes output choice based on what it expects firm B to produce, and vice versa.

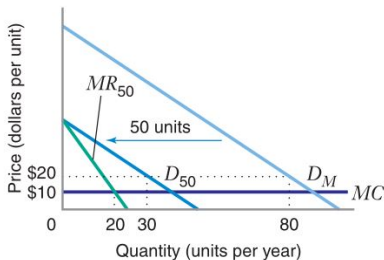
Cournot Oligopoly Model

A firm's **residual demand curve** is the demand curve that the firm faces, given its competitor's decision.

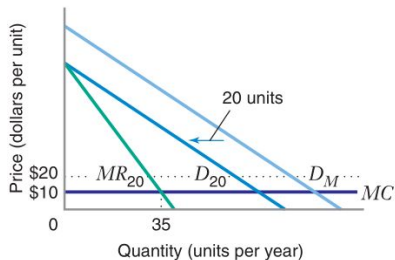
For example, suppose firms A and B face the demand curve $P = 100 - Q$, where $Q = Q_1 + Q_2$.

- If firm B decides to produce 50 units, for example, then firm A faces the residual demand curve $P = 100 - Q_1 - 50$ or $P = 50 - Q_1$.
- Likewise, if firm B decides to produce 20 units, then firm A faces the residual demand curve $P = 80 - Q_1$.

Cournot Oligopoly Model



(a) Samsung's profit-maximization problem when LG produces 50



(b) Samsung's profit-maximization problem when LG produces 20

Cournot Oligopoly Model

Each firm acts as a monopolist relative to its residual demand curve.

- In other words, it sets $MR(Q_i) = MC(Q_i)$, where MR is determined from their residual demand curve

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The resulting optimal quantity will depend on the other firm's decision.

- For firm A, for example, we will find $Q_A^*(Q_B)$

These functions for the optimal quantity are the firm's **best response functions**, or **reaction functions**

- They indicate the *best response* of one firm to another firm's level of output.

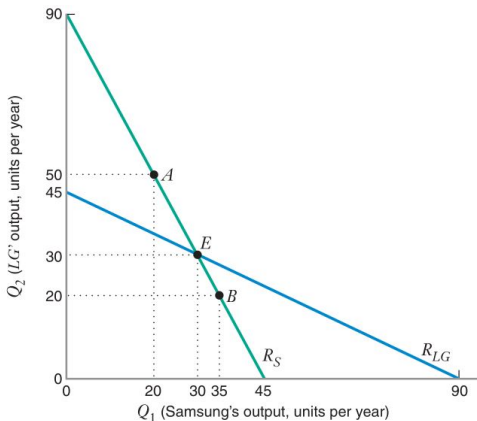
Cournot Oligopoly Model

The **Cournot Equilibrium** is the point where the two curves intersect:

- At this intersection, neither firm has an incentive to change their quantity.
- That's because their quantity is the *best response* to the other firm's output choice.

Cournot Oligopoly Model

Below are the best response functions of two firms in a duopoly. The intersection of their curves is the Cournot Equilibrium



Try It Yourself

In the Cournot model, the firm chooses

- A) its optimal price, holding the price of its competitors constant.
- B) its best response to the price changes of the competitor firm.
- C) its optimal level of output, holding the output of the other firm constant.
- D) the level of output that would optimize profits for all firms.

Cournot Oligopoly Model

Example: Suppose that market demand is given by $P = 100 - Q_1 - Q_2$, where Q_1 and Q_2 are the amount of output produced by firms 1 and 2, respectively. Marginal cost for each firm is \$10.

Firm 1's marginal revenue function can be found by taking the derivative of $P * Q$:

$$MR(Q_1) = \frac{\partial(100Q_1 - Q_1^2 - Q_1Q_2)}{\partial Q_1} = 100 - 2Q_1 - Q_2$$

Likewise for firm 2:

$$MR(Q_2) = \frac{\partial(100Q_1 - Q_1Q_2 - Q_2^2)}{\partial Q_2} = 100 - Q_1 - 2Q_2$$

Cournot Oligopoly Model

Firm 1's best response function is found by setting

$$MR(Q_1) = MC(Q_1):$$

$$100 - 2Q_1 - Q_2 = 10 \implies Q_1^* = 45 - \frac{1}{2}Q_2$$

Likewise for firm 2:

$$100 - Q_1 - 2Q_2 = 10 \implies Q_2^* = 45 - \frac{1}{2}Q_1$$

Cournot Oligopoly Model

To find the Cournot equilibrium, we simply solve the system of two equations. Let's plug firm 2's BR function in to firm 1's BR function.

$$Q_1 = 45 - \frac{1}{2}(45 - \frac{1}{2}Q_1) = 22.5 + \frac{1}{4}Q_1$$

Solving for Q_1^* :

$$\frac{3}{4}Q_1 = 22.5 \implies Q_1 = 30 \implies Q_2 = 45 - \frac{1}{2} * 30 = 30$$

Finally, plugging this into the demand curve gives us the price

$$P^* = 100 - Q_1 - Q_2 = 100 - 30 - 30 = 40.$$

Cournot Oligopoly Model

Note that the equilibrium price is above marginal cost, so this does not correspond to the perfectly competitive equilibrium. However, as the number of firms increases in this model, total profit falls.

Number of Firms	Price	Market Quantity	Per-Firm Profit	Total Profit
1 (monopoly)	\$55.0	45.0	\$2.025	\$2.025
2	\$40.0	60.0	\$ 900	\$1,800
3	\$32.5	67.5	\$ 506	\$1,519
5	\$25.0	75.0	\$ 225	\$1,125
10	\$18.2	81.8	\$ 67	\$ 669
100	\$10.9	89.1	<\$ 1	\$ 79
∞ (perfect competition)	\$10.0	90.0	0	0

Try It Yourself

Suppose that firms A and B are Cournot duopolists in the salt industry. The market demand curve can be specified as $P = 200 - Q_A - Q_B$. The marginal cost to each firm is \$40. What is firm B's profit-maximizing quantity when firm A produces an arbitrary output Q_A ?

Bertrand Model of Oligopoly

The **Bertrand model of oligopoly** assumes that firms each select a selling price.

- Consumers know both prices, and will purchase from whomever has the lowest price.
- Once a firm sets their price, they are able to supply as many units as consumers want.
- If one firm sets their price lower than the other, they will capture all of the demand in the market.

Bertrand Model of Oligopoly

A **Bertrand equilibrium** occurs when each firm chooses their profit-maximizing price, given the price set by the other firm.

Going back to our previous example, suppose two firms compete in a duopoly market. Both firms face a marginal cost of \$10.

- Suppose that both firms initially charge \$40 for a unit of the good.
- If firm A decides to undercut firm by \$1, they will capture the whole market.

Bertrand Model of Oligopoly

But then firm B will have an incentive to lower their price.

- They would keep competing in this way until the price was equal to their marginal cost (it's turtles all the way down).
- Beyond that point, if they lowered their price more, profit would be negative.

Bertrand Model of Oligopoly

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- They would keep competing in this way until the price was equal to their marginal cost (it's turtles all the way down).
- Beyond that point, if they lowered their price more, profit would be negative.

The result is that both firms charge their marginal cost, and neither firm makes a profit.

- Compare this to the Cournot model, where the firms both charged a price above MC.

Comparing Bertrand and Cournot

Why are the results of these two oligopoly models so different?

- Cournot can be thought of as taking place over a longer time period.
- Firms choose their capacity and then compete as price setters.
- In contrast, Bertrand can be thought of as short-run, where both firms have enough capacity to satisfy market demand.

Comparing Bertrand and Cournot

Cournot oligopolists expect competitors to adjust prices immediately to keep sales constant.

- So one firm cannot quickly undercut the other to steal their sales.

In Bertrand, the opposite is true.

- Each firm knows its competitors may undercut its price, so they behave more aggressively by keeping their price lower.